ARVOR-C - 33-16-010_UTI

USER MANUAL

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1 INTRODUCTION

ARVOR-C is a subsurface profiling float developed jointly by IFREMER and MARTEC Group. Since January 1st, 2009 **nke** has integrated profiling floats activity and is now in charge of ARVOR-C manufacturing and development in industrial partnership with IFREMER.
ARVOR-C is the successor of ARVOR float, from which it takes up most of the essential sub-assemblies..

The ARVOR float designed for the ARGO Program. This international program will be a major component of the Global Ocean Observing System (GOOS). An array of 3,000 free-drifting profiling floats is planned for deployment in 2004. These floats will measure the temperature and salinity of the upper 2,000 meters of the ocean, allowing continuous monitoring of the ocean's climate.

All Argo measurements will be relayed and made publicly available within hours after collection. The data will provide a quantitative description of the evolving state of the upper ocean and the patterns of ocean climate variability, including heat and freshwater storage and transport. It is expected that ARGO data will be used for initialization of ocean and coupled forecast models, and for dynamic model testing. A primary focus of Argo is seasonal to decadal climate variability and predictability.

After launch, ARVOR-C 's mission consists of a repeating cycle of descent, ascent and data transmission. During these cycles, ARVOR-C dynamically controls its buoyancy with a hydraulic system. This hydraulic system adjusts the density of the float causing it to descend or ascend. The user selects the date he wants the float to be on surface for Iridium transmission.

During its mission, ARVOR-C collects measurements of three parameters - salinity, temperature and depth (CTD) - and saves them in its memory. These measurements can be made during the float ascent (ascent profile).

After each ascent, ARVOR-C transmits its saved data to the satellites of the Iridium system. The volume of data is reduced using a compression algorithm in order to reduce the time needed for transmission. A GPS position is included in technical message during its stay on the sea surface.

This manual describes the ARVOR-C float, how to use it and safety precautions to be observed during handling.

Please read this manual carefully to ensure that ARVOR-C functions as intended.

Overview of the present manual's contents:

- Chapter 2 contains the instructions necessary for the personnel in charge of the deployment
- Chapter 3 describes the components of ARVOR-C; it is intended for those who want a more in-depth understanding of ARVOR-C
- Chapter 4 describes the mission of ARVOR-C
- Chapter 5 describes the various parameters
- Chapter 6 describes the various IRIDIUM messages
- Chapter 7 presents the technical specifications
- Chapter 8 provides explanations about the operation of ARVOR-C
- Chapter 9 specifies the elements of the constraints limited to the transport of Lithium batteries.

2 OPERATING INSTRUCTIONS

The following instructions tell you how to handle, configure, test and launch the ARVOR-C float. Please read these instructions carefully and follow them closely to ensure your ARVOR-C float functions as intended.

2.1 Handling Precautions

ARVOR-C is designed to withstand submersion at great depths for long periods of time (up to five years). This remarkable specification in oceanographic instrumentation is possible thanks to the protection of the casing by an anti-corrosion coating. This coating is sensitive to impact. Damage to the coating can accelerate the corrosion process.

NOTE: ***Take precautions to preserve the anti-corrosion coating during handling. Remove the float from its packing only when absolutely necessary.***

NOTE: ***Regulations state that ARVOR-C must not be switched on during transport.***

2.2 Acceptance Tests

Immediately upon receipt of the ARVOR-C float, you should test it to confirm that it is complete, correctly configured and has not been damaged in shipment. If your ARVOR-C float fails any of the following tests, you should contact **nke electronics**.

2.2.1 Inventory

The following items should be supplied with your ARVOR-C float:

- The present user manual.
- A test sheet.

NOTE: ***Disassembly of the float voids the warranty.***

Check that all of the above items are present. If any are missing, contact **nke**.

2.2.2 Physical Inspection

Upon the opening of the transport casing, visually inspect the float's general condition: Inspect the transport container for dents, damage, signs of impact or other signs that the float has been mishandled during shipping.

Inspect the CTD sensor, antenna, hull, housing around the lower bladder for dents or any other signs of damage

NOTE: ***Ensure the magnet is in place against the hull.***

2.3 Default Parameters

Notwithstanding special instructions given to NKE during the ARVOR-C preparation stage, the following set of parameters is applied: **section 5. page 22**

If these parameters are not appropriate, the user can change them himself by following the instructions.

2.3.1 ARGO Identification

The user is responsible for contacting the AIC in order to obtain the WMO number which will identify the ARVOR-C 's mission

2.3.2 Decoding

The CORIOLIS project team (IFREMER) is able to assist the teams that use ARVOR-C for data processing

2.4 Launching

Following is what you should do to launch the ARVOR-C float.

2.4.1 Test the Float and arm the mission

Before you take ARVOR-C on deck for deployment, we recommend that you repeat all of the tests described in **section 2.5 page 9**. This will ensure that the float is functioning and configured correctly and maximize the probability of success of your experiment.

IMPORTANT: Before launching the float, you must arm the mission by issuing the !AR command:

!AR

ARVOR-C will respond:

<AR ON>

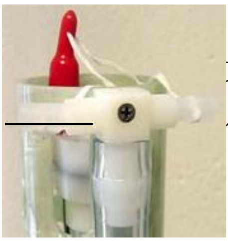
Put the magnet on the float.

NOTE: Once the mission is armed, the next time you will attempt to communicate with the float upon magnet removal, you need to connect on bluetooth and press "ENTER" within 40 seconds (before the pump starts) in order to get the prompt].

2.4.2 Remove protective plugs and magnet

The pump system of the CTD sensor is sealed by 3 protective plugs. Remove these plugs from the sensor before launching.

CTD sensor



Protective plugs

Remove the magnet located near the top of the float (see **Figure** 1 – General view of ARVOR-C float **2: page 17**). Retain the magnet for future use in case the float is recovered.

ARVOR-C is now ready for launch.

To confirm that the magnet has been removed and that the float is ready for launch, 5 seconds after magnet removal, ARVOR starts 5 valves actions. After 80s, the seabird pump is active. If you have water in the CTD, this water go out by the holes where was the protectives plugs. After 100 sec, floats starts 5 quick valve activations..

NOTE: Once the magnet has been removed, the ARVOR-C float performs an initial test. Ensure that the pump starts as explained above before placing the float in the water.

If your do not hear the valve running after 30 seconds and you do not see water move in SBE cell circuit, replace the magnet, connect the PC, and conduct the tests described in **section 2.5 page 9**. If these tests fail, contact **nke** technical support.

2.4.3 Launch the Float

NOTE: Keep the float in its protective packaging for as long as possible to guard against any nicks and scratches that could occur during handling. Handle the float carefully, using soft, non-abrasive materials only. Do not lay the float on the deployment vessel's unprotected deck. Use cardboard or cloth to protect it.

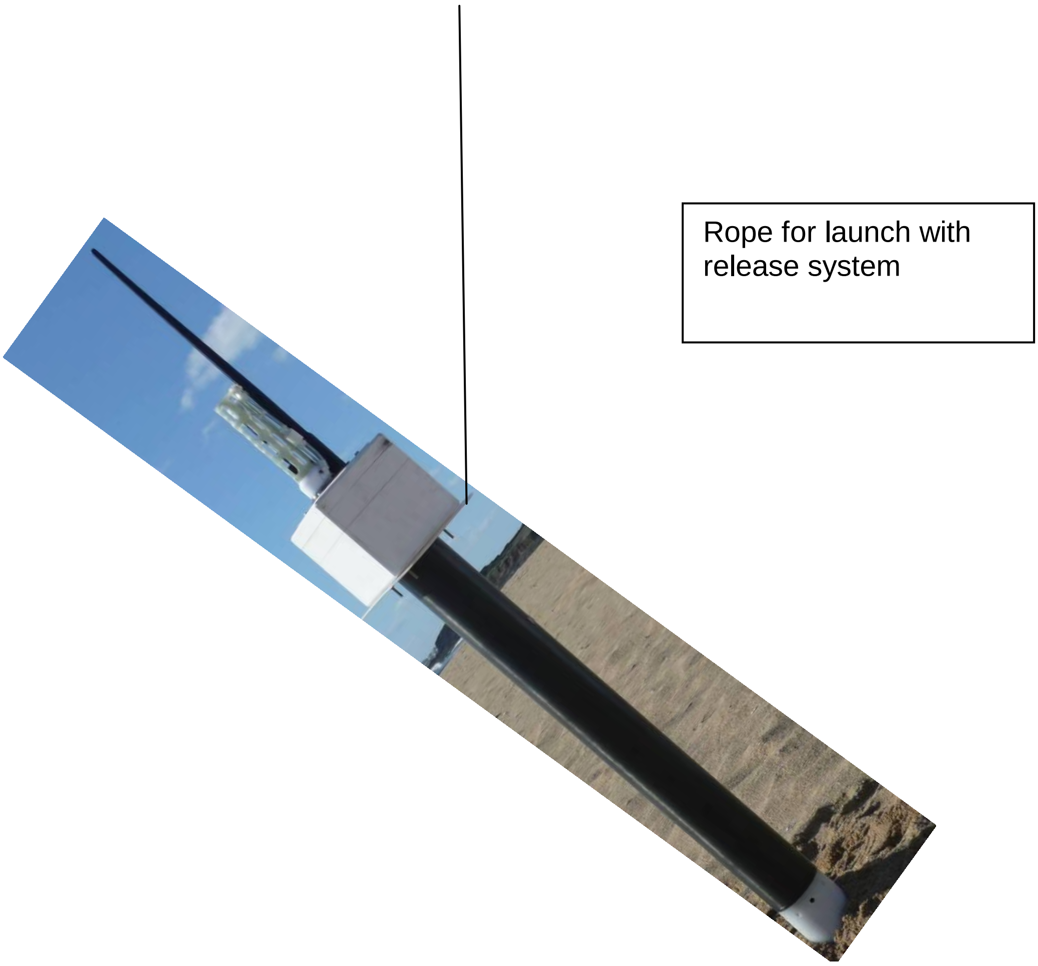
2.4.3.1 By hand

ARVOR-C can be launched by hand from the deck from a height of 3 meters

2.4.3.2 Using a rope

The damping disk is already fastened on the tube (under the buoyancy foam).
It is possible to use the holes in the damping disk in order to handle and secure the float during deployment.

Put the rope in the hole according to the following photo:



After the launch, you may decide to wait alongside the float until it starts its descent, but this can take up to 30 min depending on the float's buoyancy when it is placed in the water.

2.5 Checks prior to deployment

2.5.1 Necessary Equipment

The equipment required to check that ARVOR-C is functioning correctly and to prepare it for the mission are:

(1) A PC.
The most convenient way of communicating with ARVOR-C is with a PC in terminal emulation mode. Among other advantages, this allows storage of configuration parameters and commands. You can use any standard desktop or laptop computer. The PC must be equipped with a serial port (usually called COM1 or COM2).

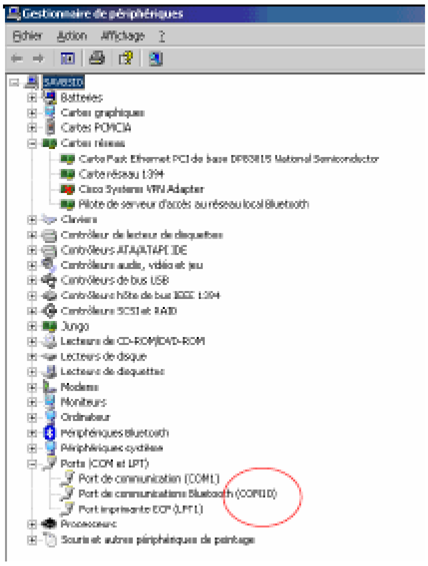
(2) VT52 or VT100 terminal emulation software.
The Hyper Terminal emulation software can be used.

(3) A Bluetooth Dongle with drivers installed on the PC (BELKIN class 2 model is recommended).

2.5.2 Connecting the PC

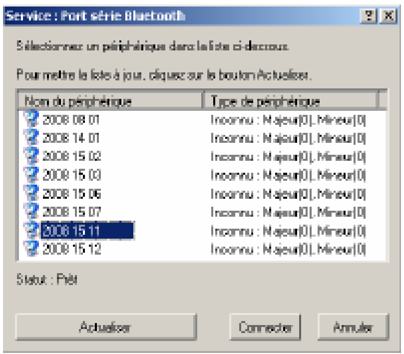
Make sure you check the following points before attempting a connection:

- ✓ Bluetooth key connected to the PC with the drivers installed
- ✓ Magnet present at the Bluetooth's power supply ILS (see **Figure 1** – General view of ARVOR-C float
- ✓ **: page 17**)
- ✓ Start Hyperterminal after checking on which COM port the Bluetooth key is installed by going to: Control Panel->System-> click on Hardware tab->Device Manager as shown in the figure below:



- ✓ On the PC, run the following commands as shown in the figure below:
- ✓ Right click on the Bluetooth logo in the bottom right corner of the Desktop
- ✓ Select Quick Connect, Bluetooth Serial Port, then click on other devices

A window appears as shown in the figure below:

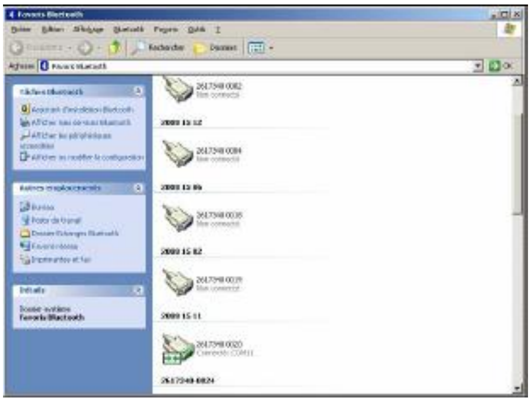


- ✓ Click on Refresh
- ✓ Check that the Bluetooth number is present on the traceability label (see **Figure** 1 – General view of ARVOR-C float
- ✓ **2: page 17**)
- ✓ There are two ways of establishing the connection:
- ✓ Either select the number shown and press Connect
- ✓ Or come back to the previous step and instead of selecting “other devices”, select the number shown
- ✓ When the connection is made, a dialog box appears as shown in the figure above:

Double click on it and a window appears as shown below:

- ✓ Enter the security code “0000”
- ✓ You can now check the connection by double clicking on the Bluetooth logo in bottom right corner of the Desktop

- ✓ The “Bluetooth favourites” window appears:



Use your PC's terminal emulation software to configure the selected serial port for:

- 9,600 baud
- 8 data bits
- 1 stop bit
- Parity: none
- Full duplex
- No flow control

2.5.3 Example of Bluetooth dongle tested by NKE

USB Bluetooth™ adaptor - 100 meters,
Part # F8T012fr
Made by Belkin

2.5.4 How to Send Commands

You must communicate with ARVOR-C to verify or change its configuration parameters, to read data from the float, or to test the float's functions. You perform these verifications/changes by sending commands, and by observing the float's response to those commands. Compose commands by typing characters on the keyboard of your PC, and send them to ARVOR-C by pressing the Enter key.
In the following descriptions of commands we will use the general syntax:

- Keystrokes entered by the user are written in **bold**.
- Replies received from the float are in normal font.
- Commands entered by the user end with the Enter key.

The software version can be viewed using the **?VL** command
ARVOR-C will respond:
<VL 5603A09>

The float’s serial number can be viewed using the **?NS** command
ARVOR-C will respond:
<NS 00001>
(identification 1)

2.5.5 How to Read and change Parameter Values

Read the values of parameters by sending the PM command. Do this by typing the characters **?PM** in response to ARVOR-C 's] prompt character then confirm the command by pressing the Enter key. It should look like this:
?PM
ARVOR-C will respond:
<PM0 255>
<PM1 0>
<PM2 60>
]

As you can see, the responses are of the form:

- PM parameter number, value.

You can also read the values of the parameters individually using the command
? PM X
where **X** identifies the parameter. Each parameter is identified by a parameter number corresponding to a parameter name.
For example, to verify the value of the ascent sampling period, send the command:

? PM 0
ARVOR-C will respond:
<PM 0 255>
]
where 255 is the number of profile user has programmed

The commands for **changing** the values of the mission parameters are of the form:
!PM X Y
where X identifies the parameter and Y provides its new value.
For example, to change the delay before mission starts to 30, send the command:
!PM 1 30

ARVOR-C will respond:
<PM1 30>

NOTE: ***ARVOR-C will always respond by confirming the present value of the parameter. This is true even if your attempt to change the parameter's value has been unsuccessful, so you should observe carefully how ARVOR-C responds to your commands.***

2.5.6 How to Check and change the Time

Connect the PC to the float using Bluetooth link (see **section 2.5.2 page 9**). Ask ARVOR-C to display the time stored in its internal clock by sending the command:

? TI

(Do this by typing the characters **? TI** followed by the Enter key). ARVOR-C will respond:

<01/03/09, 14 41 00>

]

The date and time are in the format DD/MM/YY, hh:mm:ss

You can set the time on the float's internal clock by sending the command:

!TI DD MM YY hh mm ss

For example, if you send the command:

!TI 01 03 09 14 30 00

ARVOR-C will respond:

<01/03/09, 14h 30m 00s>

2.5.7 How to program and check Date for float to be on surface

User have to program all date and time he wants float be on surface (end of each cycle with data transmission) with command LO. Maximum dates number is 400.

You can set all dates by sending the command :

!LO <CR><LF>

Floats answer :

R

Then you can enter each date with format **JJ MM AA hh mm** followed bycharacter **ENTER** (as all commands from user to float)

Once all dates are entered, you can send letter **f** followed by **ENTER**

Float answer

<LO OK>

You can check all programmed dates with this command :

?LO

Float will indicate all programmed date.

Example of programmation (short mission with 8 cycles only for example):

User -> Float : **!LO**

Float -> User : **R**

User -> Float : **12 06 11 08 00 00**

User -> Float : **12 06 11 12 00 00**
User -> Float : **12 06 11 16 00 00**
User -> Float : **12 06 11 20 00 00**
User -> Float : **13 06 11 08 00 00**
User -> Float : **13 06 11 12 00 00**
User -> Float : **13 06 11 16 00 00**
User -> Float : **13 06 11 20 00 00**
User -> Float : **F**
Float -> User : <LO OK> <CR><LF>

Then, to check if all dates are correctly programmes, you cand send **?LO** command, float will send you this :
12/06/11, 08:00:00
12/06/11, 12:00:00
12/06/11, 16:00:00
12/06/11, 20:00:00
13/06/11, 08:00:00
13/06/11, 12:00:00
13/06/11, 16:00:00
13/06/11, 20:00:00
]
In that case, User programmed 8 Profile. (8 dates for float to be on surface).
So You can check, that 8 Cycles are programmed by checking Mission Parameter number 0
Send the command **?PM**
Float will send this :
<PM0 **8**> // PM0 value has changed to 8, as, user entered 8 date for surfacing
<PM1 0>
<PM2 60>
]
This step is very important, because, in case of trouble in programmed dates, float could be lost. You have to check carefully that each date for float to be on surface let enough time for float to descend, ascend and transmit data.

To check this, you have to consider an average speed of 20cm/s in descent phase and an average speed of 30 cm/s in ascent phase.

This phase of date programmation could be quite long because float can realize many cycles, butu have to be done and check very carefully.

2.5.8 Configuration Check

The float has been programmed at the factory except programmed Dates on surface. The objective of this portion of the acceptance test is to verify the float's configuration parameters.

Connect the PC to the float (see **section 2.5.2 page 9**). Send the PM command, as explained in **section 2.5.5. page 12**, to verify that ARVOR-C 's parameters have been set correctly.

2.5.9 Functional Tests

Connect the PC to the float (see **section 2.5.2 page 9**).

NOTE: The hydraulic components will function correctly only if the float is in a vertical position with the antenna up.

Orient the float vertically, and support it to prevent it from falling over during the performance of the functional tests.

ARVOR-C has several commands that allow you to test its various functions.

2.5.9.1 Display of technological parameters

This command is used to display:

- Internal vacuum (V).
  This vacuum is drawn on the float as one of the final steps of assembly. It should be between 500 and 700 mbar absolute. 600 mbar is recommended.

- Battery voltage (B)
  Normal values for a new battery are 10.8 volts (see test sheets for limits).

Send the command:

?VB

ARVOR-C will respond:

<V:600 B:10400>. Means 600 mBar internal and 10.4V Battery pack voltage

2.5.9.2 Display Sensor Data

This command is used to display:

- External pressure (P).
- Temperature (T).
- Salinity (S).

Send the command:

?S

ARVOR-C will respond:

<S P10cBars T22956mdc S0mPSU>
As this sensor is in open air, only the temperature data should be regarded as accurate.

2.5.9.3 Test Hydraulic Pump

To activate the pump for one second, send the command:

!P 100

Listen for the pump running for one second (unit: centiseconds).

2.5.9.4 Test Hydraulic Valve

To activate the valve for one second, send the command:

!E 100

Listen for the actuation of the valve (unit: centiseconds).

2.5.9.5 Test Iridum/GPS Subsystem

To test the Iridium transmitter, send the command:

!SE

The float will reprogram time with GPS (need to be visible from Satelllite), then will send a technical SBD message. Put the magnet back in place to stop the transmission.

This command will cause ARVOR-C to transmit one technical message. The format of which is described in **section 6 page 25**. Use your email address to check transmission was OK. The message content is not meaningful, this is a test of the transmission only.

You have now completed the functional tests. Ensure the magnet is in place on the ON/OFF position (see **Figure** 1 – General view of ARVOR-C float
2: page 17).

3 GENERAL DESCRIPTION OF ARVOR-C FLOAT

3.1 ARVOR-C

The common elements between ARVOR-C and PROVOR CTS-3 are the buoyancy engine and the main sensor (C, T, D)

The main developments of ARVOR-C compared to the CTS-3 float are mainly:

- ✓ Embedded software,
- ✓ Electronics,
- ✓ Battery pack,
- ✓ Float casing, frame
- ✓ MMI link

3.1.1 Electronics

A new CPU board has been developed to take in account the obsolescence of components of the CTS-3 PROVOR profiler.

3.1.2 Embedded software

The CPU board is equipped with a new embedded software taking in account supplementary inputs and possibilities required by the ARVOR-C float.

3.2 Hull

The ARVOR-C float is encased in an aluminium cylinder measuring 11.3 cm in diameter and 100 cm in height. A surface finish prolongs life by impeding corrosion. The float is carefully designed to have a compressibility that is lower than that of seawater, essential for stable operation at ocean depths where pressures reach 50 atmospheres.

The influence of surface swell upon the instrument's heave is attenuated by a syntactic foam pad positioned around the upper part of the hull.

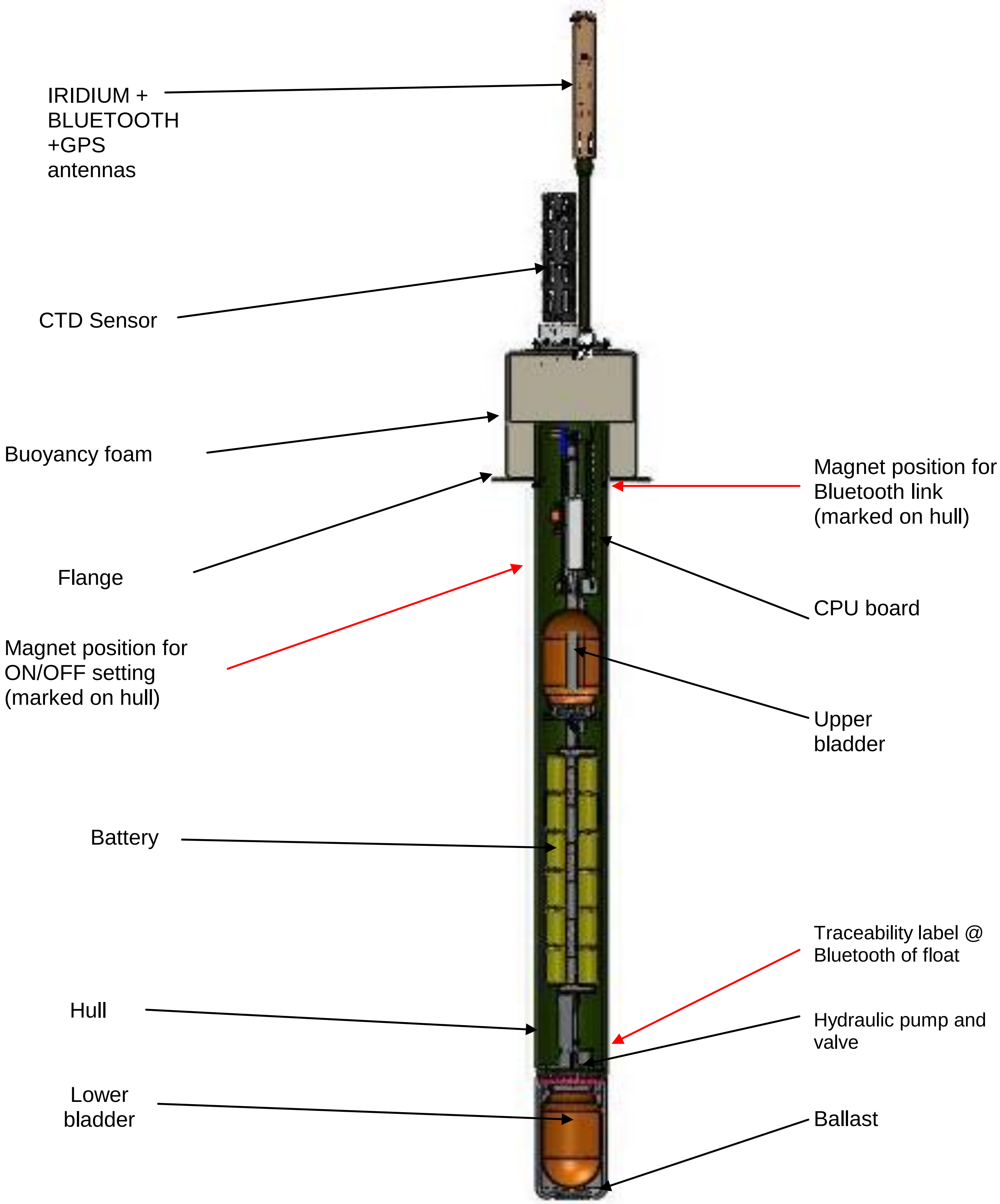


Figure 1 – General view of ARVOR-C float

3.3 Density Control System

Descent and ascent depend upon buoyancy. ARVOR-C is balanced when its density is equal to that of the level of surrounding water. The float has a fixed mass. A precision hydraulic system is used to adjust its volume. This system inflates or deflates an external bladder by exchanging oil with an internal reservoir. This exchange is performed by a hydraulic system comprising a high-pressure pump and a solenoid valve.

The interested reader is referred to a more detailed description of the operation of ARVOR-C 's density control system in **section 8. page 32**.

3.4 Sensors

ARVOR-C is equipped with precision instruments for measuring pressure, temperature and salinity with the SEABIRD SBE41CP CTD sensor. Specifications of the sensor are provided in **section 6. page 25**.

3.5 IRIDIUM/GPS MODEM

While the float is at the surface, the Iridium Modem sends stored data to the satellites of the Iridium system (see **sections 6. page 25 and 6.1. page 25**). The transmitter has a unique IMEI ID. This ID identifies the individual float. The antenna is mounted on the top end of the ARVOR-C float and must be above the sea surface in order for transmissions to reach the satellites.

3.6 CPU Board

This board contains a micro-controller (or CPU) that controls ARVOR-C . Its functions include maintenance of the calendar and internal clock, supervision of the depth cycling process, data processing and activation and control of the hydraulics.

This board allows communication with the outside world for the purpose of testing and programming.

3.7 Battery

A battery of lithium thionyl chloride cells supplies the energy required to operate ARVOR-C .

3.8 MMI link

The User link is made via Bluetooth (radiofrequency link)

4 THE LIFE OF AN ARVOR-C FLOAT

The life of an ARVOR-C float is divided into four phases: Storage/Transport, Deployment, Mission, and Life Expiry.

(1) Storage/Transport
During this phase, the float, packed in its transport case, awaits deployment. The electronic components are dormant, and float's buoyancy control functions are completely shut down. This is the appropriate status for both transport and storage.

(2) Deployment
The float is removed from its protective packaging, configured, tested and launched at sea.

(3) Mission
The mission begins with the launching of the float. During the Mission, ARVOR-C conducts a pre-programmed number of cycles of descent, Station at ground, ascent and data transmission. During these cycles it collects CTD data and transmits it to the Argos satellite system.

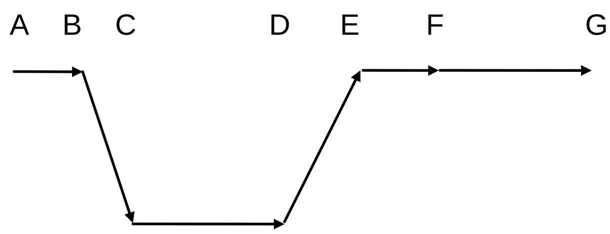
(4) Life Expiry
Life Expiry begins automatically upon completion of the pre-programmed number of cycles. During Life Expiry, the float, drifting on the sea surface, periodically transmits messages until the battery is depleted. Reception of these messages makes it possible to locate the float, to follow its movements and, if desired, to recover it. ARVOR-C floats are designed to be expendable, so recovery is not part of its normal life cycle.

If the battery is depleted before completion of the pre-programmed number of cycles, ARVOR-C will probably remain submerged and cannot be located or recovered.

4.1 The Mission - Overview

We call "Mission" the period between the moment when the float is launched at the experiment zone and the moment when the data transmission relating to the final depth cycle is completed.

During the Mission, ARVOR-C conducts ascent profiles, separated by periods of Iridium transmitting and Station at ground. ARVOR-C can collect data ascent portions of the cycle, and transmits the collected data during the surface drift period at the end of each cycle. One cycle is shown in the figure below.



AB	: Buoyancy reduction
BC	: Descent on ground
CD	: station on ground
DE	: Ascent (profile)
EF	: Buoyancy increase
FG	: Iridium transmission

Figure 2 - Schematic representation of a ARVOR-C 's depth-cycle during the Mission.

(1) Delay Before Mission
To prevent ARVOR-C from trying to sink before it is in the water, the float waits for this time before starting its descent. This happens only before the first cycle; it is not repeated at each cycle.

(2) Buoyancy reduction
Float is deployed with full external bladder to get a maximal buoyancy. To reach a neutral buoyancy position before descending, float needs to transfer oil inside float. This phase can take up to 15 minutes (by opening electro-valve) with pressure monitoring.

(3) Descent
The float descends at an average speed of 20-30 cm/sec. During descent, which typically lasts a few minutes), ARVOR-C do not collect CTD measurements.

(4) Station on Ground
During these period, ARVOR-C is grounded.

(5) Wait for Ascent Time
The user can program several floats to conduct profiles simultaneously. This makes it possible to use several ARVOR-C floats in a network of synoptic measurements, even though the instruments are not all deployed at the same time. If this is the case, it may be necessary for ARVOR-C to standby at the profile starting depth while awaiting the scheduled ascent time. As float can take time to “takeoff” from ground, float can arrive on surface later than expected.

(6) Ascent
Ascent lasts a few hours, during which time ARVOR-C ascends to the sea surface at an average speed of 20-30 cm/sec. ARVOR-C can collect CTD measurements during descent or ascent.

(7) Transmission
At the end of each cycle, the float finds sufficient buoyancy to ensure Iridium transmission quality. ARVOR-C remains at the sea surface transmitting the data collected during the preceding descent-drift- ascent portion of the cycle.

4.2 Descent

While the float is still at the sea surface ARVOR-C measures and records its pressure sensor offset. This offset is used to correct all pressure measurements. The offset is transmitted in a technical message (see **section 6. page 25** for a description of the technical message format). Descent takes the float from the sea surface to the drift depth. Initially, in order to avoid possible collisions with ships, ARVOR-C 's objective is to lose buoyancy in the shortest possible time. It does this by opening the solenoid valve for a time period that is initially long, but decreases as the float approaches its target depth.

If the user chooses, ARVOR-C will collect CTD measurements during descent or during ascent. The interval between CTD measurements is user-programmable.

During Descent , if maximum operational Pressure is reached without grounding, float ascent immediately, enter Transmission phase and go back on descent to realize programmed cycle.

4.3 Station at ground

While ARVOR-C is grounded, it checks the external pressure every 30 minutes to determine whether there is need either for depth adjustment or for an emergency ascent.

If the measured pressure differs from the max depth pressure by more than a specified tolerance, and this difference is maintained, ARVOR-C adjusts its buoyancy to return to the ground.

If the pressure increases by an amount that exceeds a factory-set danger threshold, ARVOR-C immediately ascends to the sea surface.

If the user chooses, ARVOR-C will collect CTD measurements at user-selected intervals during submerged drift.

4.4 Ascent

The float waits for the programmed time to begin the ascent.

ARVOR-C ascends by repeated use of the pump. When the pressure change between two successive measurements is less than 1 bar, the pump is activated for a pre-set time period. In this way, the pump performs minimum work at high pressure, which ensures minimum electrical energy consumption. The average speed of ascent is approximately 20-30cm/sec.

When the pressure drops below 1 bar (signifying completion of ascent), ARVOR-C waits 10 minutes and then activates the pump in order to empty the reservoir and achieve maximum buoyancy. If the user chooses, ARVOR-C will collect CTD measurements during descent and/or ascent. CTD measurements begin at the profile start time and stop 10 minutes after the float rises above the 1 bar isobar in its approach to the sea surface.

4.5 Transmission

The data transmission process takes into account the limitations of the Iridium data collection system, including:

- the uncertainty of the float's antenna emerging in rough seas;
- radio propagation uncertainties due to weather conditions, and;
- the satellites' operational status.

ARVOR-C creates transmission messages from the stored data.

Please refer to **section 6. page 25** for a detailed description of the transmitted message formats.

4.6 End Of life

Float can enter in End-Of life mode if programmed number of cycle is reached or if Battery voltage is lower enough to realize cycle. In this mode float send technical Iridium messages at specified period (PM 2, see next page).

5 ARVOR-C PARAMETERS

ARVOR-C 's configuration is determined by the values of its mission parameters defined below. Instructions on how to read and change the values of these parameters are provided in **sections 2.5.5. page 13**. The following table summarizes all parameter names, ranges and default values.

Command no.	Name	Default Value	Units
Mission Parameters			
PM0	Number of Cycles	**255**	**Whole number**
PM1	Delay before mission starts	**0**	**Minutes**
PM2	Iridium End Of Life Period	**60**	**Minutes**

Table 1 - Summary of ARVOR-C user-programmable parameters

5.1 Mission Parameters

PM(0) Number of Cycles

This is the number of cycles of descent, submerged drift, ascent and transmission that ARVOR-C will perform. The mission ends and ARVOR-C enters Life Expiry mode when this number of cycles has been completed. This number of cycle is calculated with number of date for float to be on surface that have been programmed (see). User can not change directly this parameter

PM(1) Delay before mission (minutes)

This is the delay before float begins its mission. This delay enable to prepare deployment operations.

PM(2) Iridium End Of life Period

This parameters specifies period of Iridium messages transmission as float has enterd in End Of Life phase.

6 IRIDIUM FORMATS

6.1 Overview

The data transmission process begins as soon as an ascent profile is completed. It starts with reduction of the data. ARVOR-C then formats and transmits the message. The reduction of data processing consists in storing the significant points of the CTD triplets arithmetic mean with the layer format.

SBD message contains one or 2 packet. One packet is a 100 bytes message

two types of packets are generated according to the content of the data frame:

- Type 0: Technical message
- Type 1: profile CTD message

The CTD message contains recorded physical measurements. The technical message contains data regarding the configuration and functioning of the float and its buoyancy control mechanism.

6.2 Technical message

Data	Format (bytes)	Resolution
Type	1	
Cycle timing		
Cycle start time	2	1 min
descent start time	2	1 min
end of descent time	2	1 min
Ascent start time	2	1 min
time at end of ascent	2	1 min
Transmission start time	2	1 min
Grounding pressure	2	1 cBar
minimum pressure in drift	2	1 cBar
maximum pressure in drift	2	1 cBar
number of valve actions in descent	1	
number of pump actions in ascent	1	
Nb of re-grounding in drift	1	
General informations		
Float's time (hh+mm+ss)	3	1 hour + 1 min + 1 sec
pressure sensor offset	1	1 dBar
internal pressure	1	5 mBars
batteries voltage drop (with regards to Unom = 10.0V)	1	0.1 Volt
Temperature	1	0.1 °C
Descent Speed	1	1 mBar/sec
Ascent speed	1	1 mBar/sec
Number of ascent messages	1	
GPS Data		
GPS latitude in degrees	1	1 degree
GPS latitude in minutes	1	1 minute
GPS latitude in minutes fractions (4^{th})	2	1 minute fraction (4^{th})
GPS latitude orientation (0= North, 1 = South)	1	
GPS longitude in degrees	1	1 degree
GPS longitude in minutes	1	1 minute
GPS longitude in minutes fractions (4^{th})	2	1 minute fraction (4^{th})
GPS longitude orientation (0= East, 1 = West)	1	
RTC state indicator (normal = 0, failure = 1)	1	
Defect mode *	1	
Not used		
	56	
Total	**100**	

* Defect mode value :

0 : no default

1 : Grounding at surface

2 : Grounding at pressure inferior to min pressure ()

3 : Max pressure reached during descent

4 : Max pressure reached during drift

5 : Low battery (inferior to 6.6V)

6 : Nb of programmed cycle is reached

10 : no programmed date for surfacing superior to actual date

11 : Message at deployment

12 : Mission start again after wait at surface

6.3 Profile CTD Message

Donnée	Format	Resolution
type	1	
1st CTD sample		
Pressure	2	1 cBar
temperature	2	1m°C
Salinity	2	1mPSU
2nd sample		
temperature	2	1m°C
Salinity	2	1mPSU
3rd sample		
…	…	
…	…	
24th sample		
Temperature	2	1m°C
Salinity	2	1mPSU
complement		
Complement	1	
TOTAL		
Packet size	100	

Pressure measurement are coded in two's complement.

Temperature measurement are coded in two's complement.

Salinity measurement are transmitted with an offset of -25000 mPSU (**except for firmware 5603L12, that transmit without any offset, from 0mPSU**).

6.4 Life Expiry Message

Life expiry messages are transmitted when the float is drifting on the surface and has completed transmission of all data from the last cycle of the Mission. Life Expiry mode continues until the recovery of the float or depletion of the battery.

The content of the life expiry message is identical to the technical message.

6.5 Iridium commmands

Each mission or technical parameter can be modified with Iridium telecommand. One parameter can be modified with one telecommand. Several telecommands can be send for one cycle.

Technical and mission parameters : new parameters are recovered at each cycle (if telecommand has been sent). So, each new parameter transmitted by telecommand is applied for following cycle.
To recover a float, User can send a telecommand to modify programmed number of cycles (PM 0 to 0). By this way, once on surface, floats enter in end of life mode mode and transmit technical messages.

7 SPECIFICATIONS

- Storage

  Temperature range.. -20°C to +50°C

  Storage time before expiry ....up to 1 year

- Operational

  Temperature range... -2°C to +50°C

  Pressure at drift depth .... max 40 bar

  Survival at sea ....up to 5 years

  Maximum number of cycles..up to 270 cycles

- Mechanical

  Length

  with antenna ....#200 cm

  Diameter

  casing ....11 cm

  damping disk ....square. 25 cm

  Weight 20kg

  Material.. anodized aluminum casing

- Sensors

  Salinity

  range...................... .... 10 to 42 PSU

  initial accuracy .... ± 0.005

  PSU resolution.. 0.001 PSU

  Temperature

  range... .... -3°C to +32°C

  initial accuracy ....± 0.002°C

  resolution...0.001°C

  Pressure

  range... .... 0 bar to 2100 dbar

  initial accuracy .... ± 2.4 dbar*

  resolution...0.1 dbar

  Offset adjusted when surfacing

(*) offset has to be adjusted at each surfacing

8 ARVOR-C OPERATING PRINCIPLE

Movement of the float through its profile is accomplished by a pump and valve system. The pump transfers oil from the inner reservoir to the outer bladder. Oil moves back to the reservoir when the valve is opened- -driven by the difference between the float's internal and external pressures.

The float's speed of ascent oscillates. This oscillation is due to the way in which the float's controller regulates its speed. The controller, using depth measurements from the float's pressure sensor, calculates the change in depth over a set period of time. With this information, the controller determines the float's speed.

When ascending, if the calculated speed is lower than desired, the pump is activated for about 10 seconds, pumping oil into the outer bladder. This produces an increase in buoyancy, which increases the speed of ascent.

As the float rises to shallower depths, its buoyancy decreases, causing the ascent speed to also decrease. When the calculated speed is too low, the pump is activated again.

This cycle repeats until the float reaches the surface.

The same regulating method is used to control the float's descent speed, by opening the valve and allowing oil to flow from the external bladder to the internal reservoir.

Why does ARVOR-C 's speed decrease as it ascends?

The buoyancy of a float is determined principally by its mass and its volume, but another factor, hull compressibility, also plays an important role. As ARVOR-C ascends, the decrease in water density reduces the float's buoyancy. At the same time, the decrease in water pressure causes ARVOR-C 's hull to expand, which increases the float's buoyancy. The two effects tend to counteract each other.

Because ARVOR-C 's compressibility is actually less than that of sea water, the decrease in buoyancy due to decreasing water density is greater than the increase in buoyancy due to hull expansion. This causes ARVOR-C 's speed of ascent to decrease as it rises in the water column.

Conversely, as the float descends, the increasing water density increases the buoyancy more than the decreasing buoyancy from hull compression. This causes ARVOR-C 's speed of descent to slow as it goes deeper.

To reduce the probability of contact with ships, ARVOR-C 's target speed during the initial stage of descent is high at shallow depths. This minimizes the time during which the float is at risk of damage.

To slow the float's descent, its controller is programmed with a series of depths at which the descent speed is halved until it reaches the target depth.

9 LITHIUM BATTERY

All batteries, both lithium batteries and batteries with other chemical elements, contain large quantities of stored energy. This is, of course, what makes them useful, but it also makes them potentially hazardous.

If correctly handled, neither alkaline nor lithium batteries present any risk to humans or the environment. Improper handling of these batteries presents potential risks to humans, but does not present an environmental risk.

The energy stored in a battery cell is stored in chemical form. Most batteries contain corrosive chemicals. These chemicals can be released if the cells are mishandled. Mishandling includes:

- short-circuiting the cells;
- (re)charging the cells;
- puncturing the cell enclosure with a sharp object;
- exposing the cell to high temperatures.

WARNING: BOTH ALKALINE AND LITHIUM BATTERIES MAY EXPLODE, PYROLIZE OR VENT IF MIS-HANDLED. DO NOT DISASSEMBLE, PUNCTURE, CRUSH, SHORT-CIRCUIT, (RE)CHARGE OR INCINERATE THE CELLS. DO NOT EXPOSE CELLS TO HIGH TEMPERATURES.

The lithium thionyl chloride cells used in ARVOR-C floats incorporate sealed steel containers, warning labels and venting systems to guard against accidental release of their contents.

WARNING: IF A BATTERY SPILLS ITS CONTENTS DUE TO MISHANDLING, THE RELEASED CHEMICALS AND THEIR REACTION PRODUCTS INCLUDE CAUSTIC AND ACIDIC MATERIALS, SUCH AS HYDROCHLORIC ACID (HCL) IN THE CASE OF LITHIUM THIONYL CHLORIDE BATTERIES, AND POTASSIUM HYDROXIDE (KOH) IN THE CASE OF ALKALINE BATTERIES. THESE CHEMICALS CAN CAUSE EYE AND NOSE IRRITATION AND BURNS TO EXPOSED FLESH.

The hazard presented by these chemicals is comparable to that presented by common domestic cleaning materials like bleach, muriatic acid or oven cleaner.

Inevitably, the battery contents will eventually be released into the environment, regardless of whether the cells are deliberately dismantled or simply disintegrate due to the forces of nature. Because of their highly reactive nature, battery materials disintegrate rapidly when released into the environment. They pose no long-term environmental threat. There are no heavy metals or chronic toxins in ARVOR-C 's lithium cells. Indeed, a recommended safe disposal method for thionyl chloride lithium cells is to crush them and dilute them in sufficient quantities of water.

Discharged batteries pose a greatly reduced threat, as the process of discharging them consumes the corrosive chemicals contained in them.

In summary, ARVOR-C 's lithium battery poses no significant or long-term environmental threats. Any threats that they do present, are short-term threats to the safety of persons mishandling the cells. These safety threats are similar to those of other common household-use materials. These threats are reduced when the cells are discharged - and exist only if the cells are mishandled in extreme ways. These threats are the same as those presented by the alkaline cells widely used by consumers.

10 GLOSSARY

CPU
Central Processing Unit. In the context of ARVOR-C , this term denotes the board that ensures the running and control of the system.

COM1, COM2.
Serial communication ports.

dbar.
1/10 bar = 1 decibar Unit of pressure used for ARVOR-C . It roughly corresponds to a depth of 1m.

IFREMER
Institut Français pour la Recherche et l'Exploitation de la MER (French Institute for the Research and the Exploitation of the Sea).

PC
Personal Computer; IBM-PC compatible.

CTD
Celerity (for salinity), Temperature, Depth.

ARVOR-C
Name given to the drifting profiler developed by **nke** and IFREMER.

PTT
Platform Terminal Transmitter (Argos transmission electronics).

Triplet
Set of three measurements (Salinity, Temperature and Depth) all taken at the same time.

RS232
Widely recognized standard for the implementation of a serial data communication link.

VT52, VT100
Video Terminal, type 52 or 100
Computer terminals developed by Digital Equipment Corporation (DEC). They are considered standard in the field.

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